Effect of Artificial Intelligence Integrated Method of Teaching Mathematics on Visuospatial Working Memory, Reasoning Ability and Achievement in Mathematics at Middle Stage

Synopsis

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1. INTRODUCTION

Education is the backbone of a nation, and it is a significant factor in ensuring the development of a country (David & Ole 2015). In the present scenario, technology is necessary for quality enhancement in all the fields including education. It plays a crucial role in performing our daily life activities by practising for new advancements in the field. Modern education system requires updating teaching strategies in the era of Artificial Intelligence. The incorporation of modern technologies in education gives rise to new possibilities. Artificial Intelligence (AI) can be significant and inventive among these technologies. The advancement in technology in recent times has already brought about substantial changes in education, opening new opportunities to teach and learn anywhere anytime and providing new tools and methods to improve learning outcomes and support innovative teaching and learning. as Artificial Intelligence in Education shows, AI is increasingly used in education and learning contexts. Artificial intelligence methods were generally employed in two ways, to design and facilitate interactive learning environments that would support learning by doing and to design and implement tutoring systems by adapting instructions for the student's knowledge state (Wayne Holmes et al.2019). The use of Artificial Intelligence (AI) in classrooms is resulting in an important change in the approaches to teaching. Teachers are using AI technologies to improve student learning, simplify administrative work, and provide more individualized learning experiences as technology advances **(**NitinVijay 2023**)**. AI-powered tools are integrated into science education to achieve various pedagogical benefits, including enhancing the learning environment, creating quizzes, assessing students' work, and predicting their academic performance(Firas Almasri 2024).Artificial Intelligence (AI) in the field of education helps process daily activities including teaching and learning. AI has been widely applied to various educational technology platforms such as 1) Automatic Assessment, 2) Personalized Learning 3) Educational games, 4) Intelligent Tutoring System (ITS) or Intelligent Computer-Aided Instruction (ICAI) (Tira Nur Fitria 2021)**.** AI-integrated methods use data analytics to customise learning experiences based on individual student needs and performance, offering real-time lesson plans and resource adjustments(James A. Kulik et.al. 2016). AI-integrated method of teaching aims to make mathematics education more effective, accessible, and personalised. Many AI tools greatly assist teachers in several keyways, teaching learning platforms personalize lessons based

on individual student performance, provide one-on-one support in subjects like math and science and other, offering explanations and feedback, thus freeing teachers to focus on more complex tasks and student support. Automated grading tools can reduce the time teachers spend on administrative tasks by automatically grading tests and assignments. Predictive analytics helps teachers to identify students at risk of falling behind, allowing for timely interventions and additional support where needed. AI content creation tools can assist in generating quizzes, flashcards, and study guides, saving teachers time and ensuring materials are closely aligned with the curriculum. Language processing tools aid in language learning by providing immediate feedback on pronunciation and grammar, and offering real-time translation, which benefits both students and teachers. AI tools can support teachers in saving time, personalizing instruction, providing actionable insights, and enhancing the overall learning experience for students. In the current educational scenario, teachers need to have the necessary skills to teach mathematics effectively. With the integration of Artificial intelligence in teaching, the teacher can improve their teaching skills to deliver meaningful learning material that enhances students' academic achievements and other educational activities. The subject of mathematics requires higher-order mental ability, there are some abilities in them which include critical thinking, analytical thinking, visual form, abstract thinking, etc. It may involve individual instruction, active monitoring, and prompt feedback to enhance the achievement of students. It can be important to present, interactive content in an engaging and interesting way to make learning more enjoyable. This could involve incorporating gamification and other fun approaches to make the subject matter more accessible to students. All levels of education including the middle stage require promoting meaningful methods in the teaching-learning process of Mathematics. López, OS. (2010) believed that when students are taught in an interactive manner, it can lead to improvements in their academic achievement. Cornoldi et al. (1995) investigated the academic performance of sixth-grade children with low visuospatial abilities and found that these children had greater difficulties in mathematics than in other subjects and had greater difficulties in active Visuospatial working memory tasks compared to passive visuospatial working memory. In a recent study, Allen et al. (2019) reported a positive effect of visuospatial working memory (VSWM) on mathematics achievements. A study by Pane et al. (2017) investigated the impact of personalized learning through AI and adaptive learning

systems, the study found that students using these systems showed significant improvement in math and reading skills compared to those using traditional methods at the secondary level. AI-integrated teaching methods use machine learning, data analytics, and intelligent tutoring systems, these systems customize the curriculum on the basis of student's learning pace and level of understanding. The study by Holmes et al. (2019) explored the role of AI in enhancing critical thinking and problem-solving abilities, the research indicated that AI tools, such as intelligent tutoring systems, helped students develop higher-order thinking skills by providing personalized feedback and complex problem scenarios in higher education. The research by Chen et al. (2020) focused on AI-driven gamification in secondary education, the study revealed that integrating AI with gamified learning environments increased student engagement and motivation, leading to better learning outcomes and retention rates. A study by Roll and Wylie (2016) looked into the effects of AI on collaborative learning, the findings suggested that AI-supported collaborative platforms improved students' communication skills and their ability to work effectively in teams by facilitating more structured and meaningful interactions at the primary level. These studies collectively indicate that AI-integrated methods can positively impact various student abilities, including academic performance, critical thinking, engagement, motivation, and collaborative skills.

Artificial Intelligent Integrated method of teaching mathematics may help both teachers and students in the teaching-learning process for improving the effectiveness of the whole learning process but there are some challenges associated with the situation for making use of these tools for students like less attention, more distraction or no familiarity with the technologies. AI is an emerging new tool but exposure of these can also make students distracted because of the wide area. Too much dependence on AI can negatively impact students' capacity for problem-solving. In the same way, excessive dependence on technology by educators may detract from their ability to instruct. The technological gap grows because of the unequal availability of AI technology, which is also a major problem because not all students have access to the required resources. Teachers at less rich resources schools might find it difficult to use AI successfully, which may result in differences in the standard of instruction. AI can also decrease the human connection between educators and students, which may have an impact on the social and emotional growth of learners as well as teacher potential for

relationship- and mentorship building. Beneficial advances caused by AI technology involve modification, real-time feedback, time management, and resource availability; but negative features such as dependency, equality difficulties, and decreased human connection must also be addressed. To maximize AI's advantages and reduce its negative attributes, it is important to find the right balance.

According to A Handbook by CBSE (2018) titled *"Artificial Intelligence Integration across Subjects for CBSE Curriculum"* CBSE has announced AI as a multidisciplinary integrated pedagogical strategy to improve teaching and learning in classes from 6 to 10 and to focus on the application of artificial intelligence and AI tools as a pedagogical aid for practical learning. Lesson Plans using AI in Classroom Teaching are available as guidelines for teachers and can be found as Lesson Plans integrating AI in Classroom Teaching.

CBSE's Initiative Encompassing Artificial Education Making school students 'AI Aware' or forging 'AI Readiness' among students is a huge task indeed. Central Board of Secondary Education has taken a 'twin initiative' in this regard. The first is to introduce AI as an elective subject in classes 8,9 and 10. To begin with, schools have to apply to CBSE and be approved to run this course. AI curriculum for classes 8 and 9 has been chalked out and a Facilitators' Handbook has been produced. CBSE is also supporting extensive teacher training for the teaching of AI in schools. The Second part of the *CBSE* initiative deals with the premise that AI is a Cognitive Science that can be linked to various subjects that concern themselves with cognition and reasoning. Almost every one of the school subjects would fall in this domain. Be it -Mathematics, Computing, Neurosciences, Psychology, Physics, Economics, Sociology, Philosophy, Languages, and some others. It is, therefore, mandated by CBSE that all its schools begin to integrate AI with other disciplines from classes 1 -12.

AI Integrated Education according to CBSE

AI integration with the other school disciplines is to be viewed from two different perspectives.

Perspective 1: The integration of subjects with AI can be a two-way process. Teachers can choose a topic that aligns with AI concepts and use it as a tool to teach the subject or demonstrate a linkage to AI knowledge and usage. For example, in Mathematics, 'Data Collection' can be demonstrated using an AI-based app, or the concept and functionality of the AI application can be taught through an understanding of Data Collection operations.

Perspective 2: A teacher can integrate AI into one subject for a more functional approach, or inter-disciplinary integration, where the teacher selects a relevant topic from another subject and collaborates with other teachers to explore the same topic, achieving the learning outcomes of their respective subjects while integrating AI. This approach is feasible in normal classroom teaching but requires large class groups over time.

1.1. AI Integrated methods of teaching

AI-Integrated Methods of Teaching mathematics involve incorporating AI technologies into the overall teaching strategy in classroom. This includes adaptive learning platforms, intelligent tutoring systems, automated grading, and enhanced teaching and learning processes. The Bill & Melinda Gates (2024) Foundation also emphasizes the potential of AI-powered tools in promoting critical thinking and creative problem-solving in mathematics education. AI-integrated method of teaching mathematics, provide a one-size-fits-all approach with limited customization based on student performance. These methods focus on improving the efficiency and effectiveness of teaching by personalizing instruction. According to CBSE Artificial Intelligence is a cognitive science and the history of its evolution suggest, it has grown out of the knowledge systems from other disciplines like science, mathematics, philosophy, sociology, computing and other, it is fair for students to see the linkages. Hence, it is fair for any education system to recognize the importance of its integration with the teaching of other disciplines, to maximize learning. Artificial Intelligence Integrated method of teaching mathematics transforms the traditional classroom by embedding AI into daily teaching practices and overall curriculum design. AI-based instructional materials mean to creation of any instructional material or content for teaching learning experiences with artificial intelligence. These materials are specific educational resources that utilize Artificial intelligence, to provide targeted practice, reinforce concepts, and offer learning material to students. Teacher can adjust content based on a student's performance to address individual learning gaps. AI-based instructional materials can be used alongside traditional teaching methods or integrated into a broader AI-driven teaching strategy. Conventional Teaching Aids Traditional, non-adaptive tools and resources used to support standard teaching practices. Remedial Teaching Material is Extra resources focused on helping struggling students. In essence, AI-based instructional materials and AI-integrated method of teaching

mathematics represent advanced, personalized approaches to education, whereas conventional teaching aids and remedial materials are more traditional and static, lacking the adaptive capabilities of AI. Artificial Intelligent Integrated method of teaching mathematics involves using AI technologies to enhance the teaching process. This includes adaptive learning platforms that tailor lessons to individual student needs, intelligent tutoring systems that provide personalized support, and automated grading tools that can reduce administrative burdens. These methods may improve the teaching and learning experience by making it more efficient, personalized, and engaging. On the other hand, AI-based instructional materials in mathematics refer to specific educational content created or enhanced by AI. These materials are designed to provide targeted practice and reinforcement of mathematical concepts, helping students to better understand and retain information. AI-integrated methods of teaching mathematics are broader strategies that enhance the overall teaching process using AI, while AI-based instructional materials are specific educational resources created or improved by AI to support learning.

1.2. AI in Mathematics Education-

AI in mathematics education has the potential to revolutionize the way students learn and teachers teach. Here are few keyways in which AI is being integrated mathematics education.

Personalized Learning: AI-integrated systems customize content based on students' learning pace, level of understanding, and individual needs. DreamBox Learning is an adaptive learning platform that customizes curriculum based on student performance and Khan Academy provides AI-enabled interactive video tutorials and practice problems.

Immediate Feedback and Correction: AI-based tools provide students with immediate solutions and feedback. like Photo Math: An app that scans and solves mathematical problems and provides step-by-step solutions, Microsoft Math Solver Provides students with immediate solutions and detailed feedback.

Data-Driven Decisions: AI systems analyse student performance data and provide teachers with insights about their students' progress. Examples: Edmodo: A platform that tracks student performance data and provides teachers with important insights. ClassDojo A platform that provides data on student behaviour and progress.

Visual and Interactive Learning: AI-based tools help students understand mathematical concepts interactively and visually. Examples: GeoGebra: An interactive geometry, algebra, and calculus tool. Desmos: An online graphing calculator.

Problem Solving and Logical Thinking: AI-based games and interactive tools teach students new approaches to solving mathematical problems. Example: Prodigy Math Game: An AI-based game that encourages students to solve mathematical problems. Google Lens and QuickDraw: Image recognition and drawing tools that help students recognize symmetry and patterns in the real world.

1.3. VISUOSPATIAL WORKING MEMORY

The term 'Visuospatial' refers to the visual and spatial components of objects. The visual aspect includes properties like shape, texture, and colour, size whereas spatial aspect refers to abilities about rotation, perspective taking, and transformation of an object. In other words, the visual aspect deals with perceptual and pictorial features of objects, while the spatial aspect processes information about motion, transformation and rotation of objects in space (Blazhenkova & Kozhevnikov, 2010). These properties are internalized as mental representations, which are transformed to carry out reasoning. Therefore, representation and transformation are the aspects of visuospatial working memory. Visual memory is responsible for retaining visual shapes and colours, whereas spatial memory is responsible for information about locations and movement. This involves holding on to information about how the features that define the object are arranged in space. The ability to recognize letters and numbers, read, write, and do math are important skills for children. These skills also play a key role in mastering advanced math subjects like geometry, trigonometry, and calculus. According to the Cornoldi and Vecchi model, it is possible to identify the different components of VSWM: visual WM that allows the temporary storage of visual information (e.g., memory of shapes and colors), spatial WM allowing the recall of positions, (e.g., memory of object positions on a chessboard), or spatial locations presented in sequences, such as for tracking a path (Cornoldi and Vecchi (2003). VSWM is considered to process and store visual and spatial information for a short time and to operate on visual images (Baddeley, 1997). It is further assumed to have two components: one static visuospatial component to process and store information about e.g. colour and shape, and one dynamic component to store information about e.g. movement sequences (Pickering, et al, 2001). According to Luck &

Vogel (2013) and Ma, Husain, & Bays (2014), The VWM system has a limited capacity for actively representing the visual appearances of relevant items. According to Jansen et al. (2013), A study was conducted to explore the relationship between visuospatial working memory and mathematics in different domains. It was found that visuospatial working memory is interconnected with mathematics and effective instructional material can be a useful tool for enhancing students' mathematical thinking, math abilities, and working memory.

1.4. REASONING ABILITY

It is important to exercise reasoning to arrive at an effective solution to any problem. This requires a higher level of cognitive function that involves careful, methodical thinking and organization. Reasoning involves exploring the cause and effect of an event or problem, using well-organized steps based on previous knowledge and current observations. It is a form of rational thinking that is employed when there is no readymade response to a problem. However, it is worth noting that reasoning skills can vary depending on the individual and the specific field in which they are working. Reasoning ability involves comparing known to unknown concepts to gain understanding. This method can be used by both children and adults to learn new information or make persuasive arguments. The brain can recognize patterns through association, making it easier to understand new concepts. By comparing a new concept to something familiar, the brain can store information more effectively. Reasoning ability is not limited to mathematics but is also applicable in our daily lives. According to Richland, Holyoak and Stigler (2004), reasoning ability may be central to learning abstract concepts of mathematics. It can help us transfer representations across different contexts. By using this, we can develop the ability to identify similarities in new situations, apply our existing knowledge to new problems, and generalize our learning. Introducing analogy as a specific method in mathematics can have numerous benefits, not just in the subject but also in real-world activities.

1.5. ACHIEVEMENT IN MATHEMATICS

There is no subject in the curriculum that activates children's minds like mathematics. Mental activity is required to solve every mathematics problem; thus, the learning of mathematics easily develops the overall mental powers of the child. The success and failure of a student is determined by his achievement in the examinations conducted in various subjects, and the achievement of a student is

shown by the marks obtained in the examination. The achievement in mathematics of the students shows obtained scores in the subject of mathematics. In the era of science and technology, a strong foundation of mathematical knowledge is essential for the development of society as well as individual education. Mathematics knowledge and skills are required for the individual during their home, school, job, business, and office, computers, problem-solving ability and decision-making ability. Therefore, mathematics is the main component of universal education and must be a compulsory school subject from class I to X. Though mathematics learning holds an important position in the school curriculum, teaching-learning of mathematics is not an easy task. Therefore, to move from rote learning to experimental learning, it is necessary to teach mathematics in an interesting and effective way with the help of AI tools. Mathematics is the most powerful and intellectually interesting branch of education. It is necessary to create an environment conducive to the mathematical performance of the students. The motive of teaching mathematics is to make every child learn and enjoy mathematics. (Whitehead A.N.(ND) Mathematics should be visualized as the vehicle to train a child to think, reason, analyse and articulate logically. Teaching-learning of mathematics develops the ability to perform computations with speed, accuracy and use of instruments, and also develops qualities like objectivity, rationality, critical thinking, and scientific thinking among the learners teaching-learning of mathematics.

2. EMERGENCE AND JUSTIFICATION

The main goal of schooling is to prepare individuals for future challenges. Therefore, it is crucial to prioritize creating positive learning environments (Balakrishnan et al., 2016). Traditionally, teachers held complete control over the teaching-learning process through teacher-centred methods such as lectures and demonstrations. However, student-centred methods, such as project-based learning, activity-based learning, and heuristic learning, have become more widespread. Today, educational policies emphasize the integration of technology, which is considered the best method of instruction. By utilizing technology, teachers can develop innovative teaching strategies to enhance students' learning abilities in mathematics. There are many applications, digital platforms, and AI tools available to provide valuable information and engaging, joyful, logical content for students, to increase their interest in the subject. Incorporating AI tools can improve student performance and enhance the

effectiveness of teaching methods. The subject of mathematics is based on higher mental abilities, so it requires full engagement of the learner to get success. Learners can be engaged if the mathematics teacher provides a meaningful platform focusing on learners' visual skills promoting reflective thinking and interpersonal interaction which can result in improved academic achievement and student interest.

The present study's focus is to enhance the use of technology in teaching teaching-learning process. Artificial intelligence-integrated methods of teaching mathematics can balance brain activity and cognitive skills, helping to prevent a variety of learning problems. It also maintains the brain activity of the learner by making learning enjoyable (Zirawaga, 2017). Mathematical educational games and activities with AI integration may help to design and shape the special learning environment (Howard-Jones, 2011). This study aims to explore how AI integrated method of teaching mathematics can enhance visuospatial working memory, reasoning ability and achievement in mathematics. The study will be focused on developing the skills through the use of AI-based educational resources. In the present study, the researcher will focus on the design and development of an Artificial intelligence integrated method of teaching mathematics, which includes Content, related Examples, Exercises, Activities, and Brain-Based Educational Games according to the demand of the content. An Artificial intelligence-integrated method of teaching mathematics will be designed and developed on the content material to improve students' visuospatial working memory, reasoning ability, and achievement in mathematics. Innovative thinking would help raise awareness of the mathematics curriculum and promote the use of AI in daily life (Ramirez, 2008). It is important to teach students the value of reasoning ability, visual reasoning, and problem-solving creativity to attract their interest in mathematics. The method of teaching on AI provides automated guidance and encourages learning as much as a human being would. (Ahmar Al. 2012). The schools play an important role in determining the level of student engagement in any subject. This is especially important for children who are learning new skills at a faster pace. Mathematics plays a significant role in children's learning as they acquire new skills. It may be feasible to determine the level where visuospatial working memory has the greatest impact on children's mathematical skills and utilize this knowledge to predict future achievement.

2.1. RESEARCH RELATED STUDIES

Table 1.1. Exhibiting Review of related studies

YEAR	RESEARCHER	RESEARCH TOPIC	RESULTS
2023	Luigi Macchitella et.al	Visuospatial Working Memory and Mathematical Skills in Children: A Network Analysis Study	Results indicate that some but not all visuospatial working memory components are associated with some mathematical abilities.
2023	Dr. Nouridin Melo	Incorporating Artificial Intelligence into The Classroom: An Examination of Benefits, Challenges, And Best Practices	In conclusion in this study, AI has the potential to provide students with personalized and engaging learning experiences, as well as help them develop important 21st-century skills such as critical thinking and problem-solving.
2023	Nur Hardiani Kristayulita	Reasoning ability in Mathematical Theorems	The results of the research show that the analogy can be applied to certain mathematical topics related to real life.
2022	Yuan Wang and Kew Si Na	Innovative Research on English Teaching Model Based on Artificial Intelligence and Wireless Communication	Develop and implement an online intelligent English training system using artificial intelligence that helps students improve their English learning efficiency in line with knowledge and personality. In combination with an AI expert system, suitable learning techniques were created to enable students to double the learning effect by half the amount of work.
2022	Qingqing Chang Xiajie Pan et.al	Artificial Intelligence Technologies for Teaching and Learning in Higher Education	The findings of the study indicate that due to the development of research on AI in higher education, AI technologies have become more efficient, adaptable, and effective compared to current traditional.
2022	Mohamed Zulhilmi bin Mohamed et al	Artificial Intelligence in mathematics education	The findings of the study indicate that the AI approach used in mathematics education for the samples studied were through robotics, systems, tools, teachable agents, autonomous agents, and a comprehensive approach.
2021	Tobias Kahl, et al	Executive Functions and Visual-Spatial Skills Predict Mathematical Achievement: Asymmetrical Associations Across Age	This study suggests that executive and visual-spatial skills related differently to mathematical proficiency across ages, suggesting a varying impact on mathematics across age.
2018	David Giofrè et.al	The differential role of verbal and visuospatial working memory in mathematics and reading	Findings point to the importance of distinguishing between WM modalities in evaluating the relationship between mathematics and reading.

2017	Rudolf Burggraaf et al	Performance on tasks of visuospatial memory and ability: A cross-sectional study in 330 adolescents aged 11 to 20	The results showed that performance on visuospatial memory and visuospatial ability tasks increases with age up to late adolescence, with no gender difference. Additionally, performance on the visuospatial memory and the visuospatial ability tasks showed a significant correlation.
2016	Kissi, Philip Siaw; et al.	The Effects of the Use of Microsoft Math Tool (Graphical Calculator) Instruction on Students' Performance in Linear Functions	This study indicated that the two groups were homogeneous. The experimental group received teaching instruction using the graphical calculator while the traditional lecture method was used to teach the control group by the same instructor.
2014	Andy V. Pham, et.al	Verbal and Visuospatial Working Memory as Predictors of Children's Reading Ability	Findings support the notion that visuospatial WM contributes to reading outcomes. Children with reading difficulties may likely rely on visuospatial WM or imagery as a strategy to process written text and comprehension, and this knowledge should be incorporated when developing or implementing reading interventions or WM training programs for children with these skills deficits.
2012	Iroise Dumontheil, Tor kel Klingberg	Brain Activity during a Visuospatial Working Memory Task Predicts Arithmetical Performance 2 Years Later	The results show that Visuospatial working memory (WM) capacity is highly correlated with mathematical reasoning abilities and can predict future development of arithmetical performance because that neuroimaging data can provide useful information in addition to behavioural assessments and be used to improve the identification of individuals at risk of future low academic performance.
2008	Minna Kyttälä	Visuospatial working memory in adolescents with poor performance in mathematics	Results indicate that the pupils with poor performance in maths showed poorer performance on certain VSWM tasks.
2007	Francesca Pazzaglia Cristin a Toso, Stefano Cacciamani	The specific involvement of verbal and visuospatial working memory in hypermedia learning	The findings support the hypothesis that both verbal and visuospatial working memory sub-components play a role in hypermedium processing, but with specific and distinct functions: the performance in the verbal working memory task was able to predict the semantic knowledge children can derive from hypermedia learning.

After going through the literature review of the areas selected, it is found that currently there is a deficit in the literature related to Artificial intelligence-integrated method of teaching mathematics.

Few national & international studies have been done on the effect of Artificial intelligence in areas such as Hindi, English, Mathematics, Science and Islamic Studies at different levels. Additionally, most research have been conducted at different educational levels, but AI integrated researches on the middle stage was conducted in very less in number. Some researchers have been done, but those were usually in combination with other subjects. However, the area of integrating AI with mathematics in the middle stage has not been touched or studied extensively. that's why the middle stage has been selected by the researcher for the present research.

In some studies, Verbal and Visuospatial Working Memory as Predictors of Children's Reading Ability has been studied. After undergoing the process of reviewing the research, the following questions arise in the mind of the researcher in the context of Artificial intelligence integrated method of teaching mathematics in the field of mathematics are as follows:

- How can artificial intelligence tools be used for developing lesson plans for mathematics?
- How does Artificial Intelligence integrated method of teaching mathematics help in developing visuospatial working memory at middle stage?
- How does Artificial Intelligence integrated method of teaching mathematics help in developing reasoning ability at middle stage?
- How does Artificial Intelligence integrated method of teaching mathematics help in developing achievement in mathematics at middle stage?

These questions led the researcher to formulate the problem of the study.

3. STATEMENT OF THE PROBLEM

In context with the above justification, the problem in hand can be stated as the **Effect of Artificial intelligence integrated method of teaching mathematics on Visuospatial Working Memory, Reasoning Ability and Achievement in Mathematics at middle stage.**

4. DEFINITION OF THE KEY TERMS

4.1. ARTIFICIAL INTELLIGENCE INTEGRATED METHOD OF TEACHING

According to Dr. Nouridin Melo (2023), “The integration of Artificial Intelligence (AI) into the classroom has the potential, way for students to learn and teach students and teachers. AI algorithms can provide personalized feedback and recommendations with the students, allowing more engaging

and effective learning experience."

According to (Merriam-Webster) "Artificial intelligence is a branch of computer science dealing with the simulation of intelligent behaviour in computer."

Operational Definition

In the present study, Artificial Intelligence Integrated Method of Teaching refers to the use of AI tools in teaching. It includes adaptive learning platforms, automated grading systems, data analytics and interactive tools with various teaching methods to create a more individualized, efficient, and engaging learning experience for students.

4.2. VISUOSPATIAL WORKING MEMORY

According to J Macfoose, and B T Baune (2008), "The ability to retain and process an object's identity and spatial location is essential for many daily tasks, often referred to as visual-spatial working memory."

According to Dehn, Milton J (2011), "Visuospatial working memory (VSWM) is involved in recalling and manipulating images to remain oriented in space and keep track of the location of moving objects."

Operational definition

In the present study, Visuospatial Working Memory (VWM) refers to the ability of students to analyse the spatial location, manipulation, direction, spatial relation, spatial transformation and visual patterns of the images or objects in term of mathematics. It is related to students' daily life tasks. The Visuospatial working memory of the students will be measured through a self-constructed test.

4.3. REASONING ABILITY

According to D. Gentner, and L. Smith (2012), "Reasoning Ability is a kind of reasoning that is based on finding a common relational system between two situations, exemplars, or domains."

Operational definition

In the present study, Reasoning Ability focuses on students' cognitive skills that can increase the logical thinking and problem-solving ability of the subject in mathematics. It involves analogical, inductive, deductive cause and effect reasoning.

4.4. ACHIEVEMENT IN MATHEMATICS

In the present study, Achievement in Mathematics refers to the performance of the students in the subject of mathematics. It will measure the scores of achievement tests in mathematics.

4.5. MIDDLE STAGE STUDENTS

In the present study, 'Middle stage Students' denotes students of grades 6 to 8 of CBSE Board School, whose age lies between 11-14 years.

5. OBJECTIVES OF THE STUDY

The objectives of the present study are as follows

1. To analyse and select the content of mathematics based on visuospatial ability at middle stage.
2. To develop lesson plans of mathematics based on Artificial intelligence-integrated method of teaching for middle stage students.
3. To study the effect of Artificial intelligence integrated method of teaching mathematics on visuospatial working memory at middle stage.
4. To study the effect of Artificial intelligence integrated method of teaching mathematics on reasoning ability at middle stage.
5. To study the effect of Artificial intelligence integrated method of teaching mathematics on achievement in mathematics at middle stage.

6. HYPOTHESES

1. **Ha1**: There will be a significance effect of Artificial intelligence integrated method of teaching mathematics on visuospatial working memory at middle stage.
2. **Ha2**: There will be a significance effect of Artificial intelligence integrated method of teaching mathematics on reasoning ability at middle stage.
3. **Ha3**: There will be a significance effect of Artificial intelligence integrated method of teaching mathematics on Achievement in mathematics at middle stage.

7. DELIMITATIONS OF THE STUDY

The study will be delimited in the following ways:

1. The study will be delimited to Agra city only.
2. The study will be delimited to the students of the CBSE Board only.
3. The study will be delimited to VII Grade students only.

4. The study will be delimited to the chapters of Mathematics which are related to visuospatial working memory.

8. VARIABLES OF THE STUDY

The variables related to the present study are depicted as follows:

8.1. Independent Variable:

Artificial intelligence integrated method of teaching mathematics

8.2. Dependent Variables:

- Visuospatial Working Memory
- Reasoning Ability
- Achievement in Mathematics

8.3. Control variables

- Age
- Class
- Subject
- School board

9. METHOD OF THE STUDY

For the achievement of the objectives of the study, Quasi Experimental method will be followed in this study

10. POPULATION, SAMPLE AND SAMPLING TECHNIQUE

In the present study, mixed-method sampling will be used by the researcher. Mixed Method Sampling involves combining probability and non-probability sampling techniques in creative ways to answer research questions (Teddlie, C.2007). CBSE has suggested AI as a multidisciplinary integrated pedagogical strategy to improve teaching and learning in classes from 6 to 10 and to focus on the application of artificial intelligence and AI tools as a pedagogical aid for teaching learning. However, the area of integrating AI with mathematics in the middle stage has not been touched or studied extensively. that's why the middle stage has been selected by the researcher for the present research. All the middle-stage students studying in the CBSE school of Agra city will comprise the Population of the Study. 80 Students of the VII class will be selected as sample of the present study. In the First

Phase, Purposive Sampling will be used for selecting CBSE

schools of Agra city. After selecting school VII grade will be selected purposively. After selecting class, two sections (named as control and experimental group) will be selected randomly and 40 students from each section will be selected intact sampling. The sample selection has been shown in the below-given diagram-

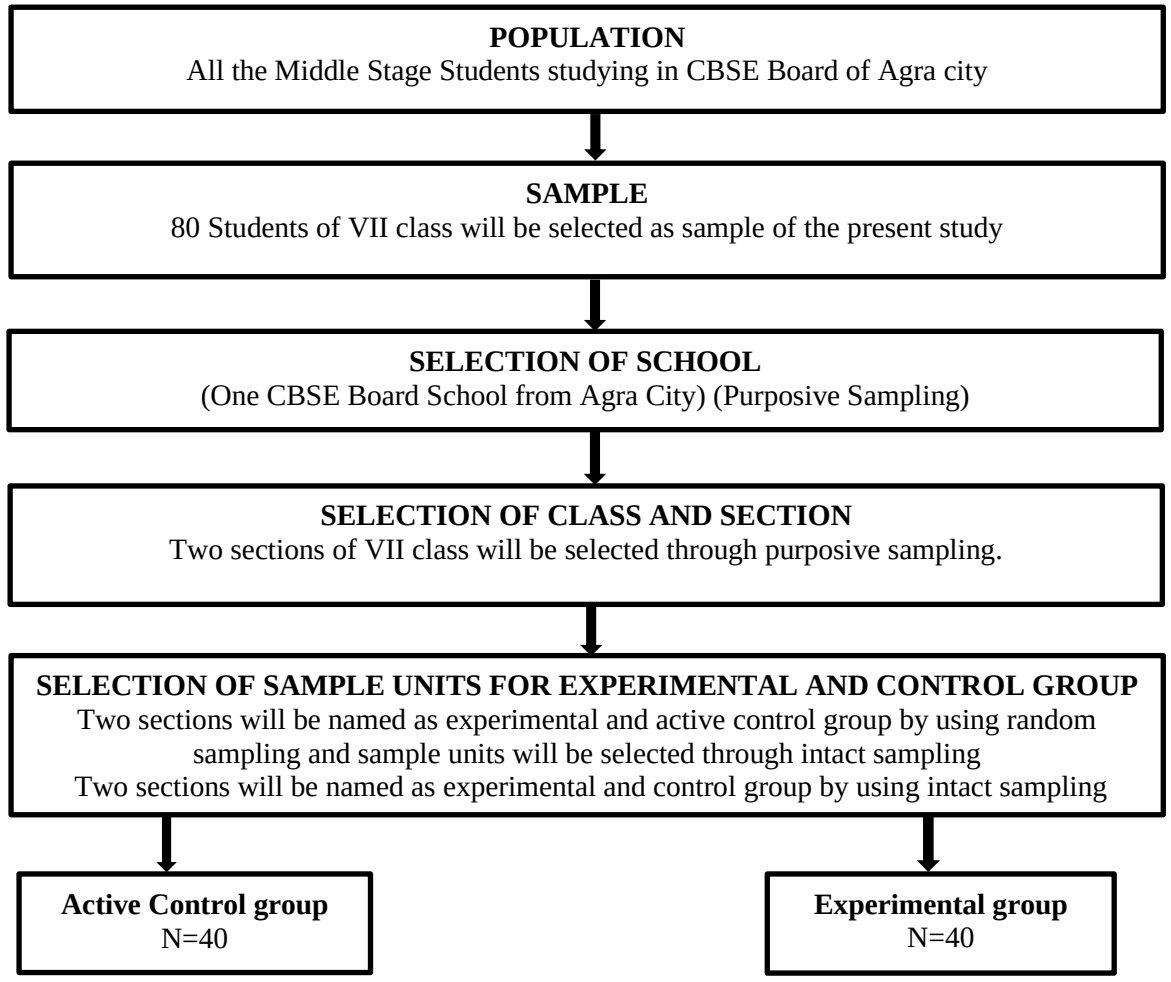
POPULATION
All the Middle Stage Students studying in CBSE Board of Agra city
SAMPLE
80 Students of VII class will be selected as sample of the present study
SELECTION OF SCHOOL
(One CBSE Board School from Agra City) (Purposive Sampling)
SELECTION OF CLASS AND SECTION
Two sections of VII class will be selected through purposive sampling.
SELECTION OF SAMPLE UNITS FOR EXPERIMENTAL AND CONTROL GROUP
Two sections will be named as experimental and active control group by using random sampling and sample units will be selected through intact sampling
Two sections will be named as experimental and control group by using intact sampling
Active Control group
N=40
Experimental group
N=40

Figure 1.1. Population and sampling techniques of the study

11. Research Design of the Study

Non-equivalent two-group pre-test and post-test research designs will be used in the present study:

Table 1.2. Showing the research design of the study

Group	Pre-test	Intervention (30 Days)	Post-test
Active Control (N=40)	1. Visuospatial working memory 2. Reasoning ability 3. Achievement in mathematics	Through traditional Approach	1. Visuospatial working memory 2. Reasoning ability 3. Achievement in mathematics
Experimental (N=40)		Through Artificial intelligence integrated method of teaching Mathematics	

12. PROCEDURE OF THE STUDY

12.1. Methodology

For the achievement of the objectives of the study, both qualitative and quantitative methods will be used:

Phase 1- (Developmental Phase) that will include the development and the construction of lesson plans based on Artificial intelligence Integrated method of teaching mathematics.

Table 1.3. Showing the Steps for developing lesson plans for the study

S.No.	Steps	Details
1.	Need & Situation Analysis of students in the context of mathematics subject	Problem identification of the mathematics students, review the existing Content
2.	Designing of content	Identify and sequence the content of mathematics based on need analysis.
3.	Developing The content	Developing lesson plans with the help of different Artificial intelligence Tools related to the mathematics subject
4.	Implementation	Expert view first Try out, revision 1, try out 2, revision 2, pilot study etc. Formative Evaluation Instructional material production
5.	Evaluation	Summative Evaluation
6.	Final Product	Artificial intelligence integrated method of teaching mathematics

Phase 2- (Experimental Phase) It will comprise of Experimentation to determine the effect of Artificial intelligence Integrated method of Teaching mathematics.

Table 1.4. Blueprint of Intervention

Time Duration	Few AI Tools will be covered in this topic
30 days Intervention (4minutes Teaching will be conducted per day)	**Autodraw-** Auto Draw is a drawing tool that uses AI to suggest images and improve sketches. Beyond teaching symmetry, Auto Draw can be utilized in various educational topics and activities, such as: Basic geometry, shapes, polygons, angles, Geometric, transformations, symmetry, Reflection, rotation and visualizing etc. **Quick draw-** Quick, Draw is a game that uses a neural network to recognize doodles drawn by players. While it's primarily designed as an interactive game, it can also be used as an educational tool in various subjects, particularly in mathematics and art. Here are some mathematics topics where Quick, Draw! can be utilized: Geometry, Fractions and Parts of a Whole Patterns and Sequences, Algebra, Measurement, Visual Problem Solving, Art and Creativity in Mathematics, Number Representation. **Alpha geometr**y- Alpha geometry is an AI powered tool that can be used as an educational tool in various subjects, particularly in mathematics and art. Here are some mathematics topics where can be utilized Alpha geometry like shapes, line and angles, symmetry, congruence and solid shapes Measurement **Draw 3D**- Visual Problem Solving, Art and Creativity in Mathematics, visualization of 3D images geometry 3D shapes. **Shape E-** Shape E is an AI powered tool that can be used as an educational tool in various subjects, particularly in mathematics and art. Like shape formation, identification of shape classification of shapes.

12.2. Steps of the Procedure

Procedure of the present study will follow these steps

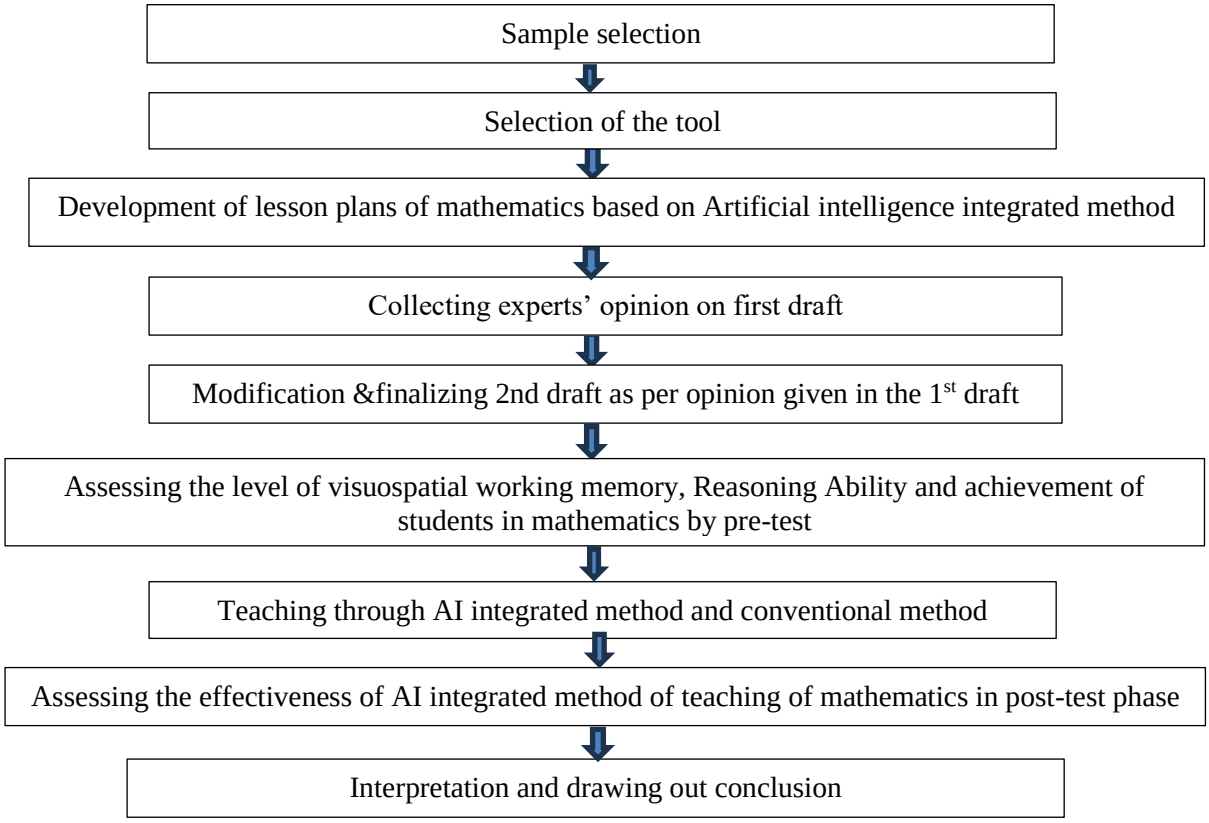
Sample selection
Selection of the tool
Development of lesson plans of mathematics based on Artificial intelligence integrated method
Collecting experts' opinion on first draft
Modification &finalizing 2nd draft as per opinion given in the 1st draft
Assessing the level of visuospatial working memory, Reasoning Ability and achievement of students in mathematics by pre-test
Teaching through AI integrated method and conventional method
Assessing the effectiveness of AI integrated method of teaching of mathematics in post-test phase
Interpretation and drawing out conclusion

Figure 1.2. Procedure of the study

13. Tools for the study

In the present study, there is one independent variable Artificial intelligence-integrated method of teaching mathematics, and three dependent variables viz. visuospatial working memory, reasoning ability and achievement in mathematics. The researcher will use the following tools for the variables:

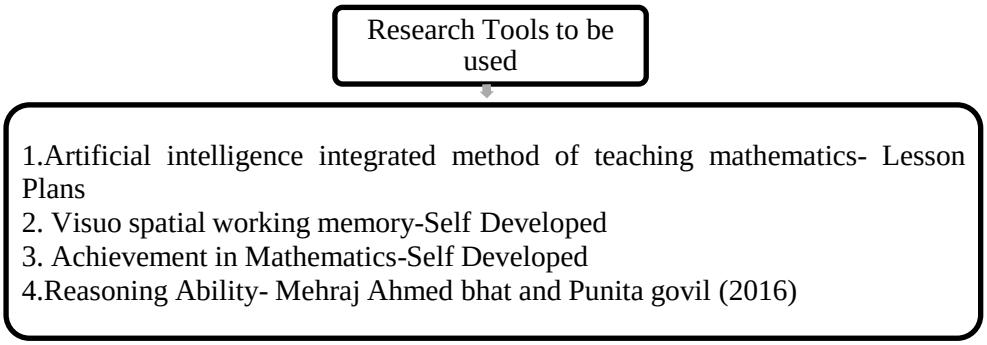
Research Tools to be used
1.Artificial intelligence integrated method of teaching mathematics- Lesson Plans
2. Visuo spatial working memory-Self Developed
3. Achievement in Mathematics-Self Developed
4.Reasoning Ability- Mehraj Ahmed bhat and Punita govil (2016)

Figure 1.3. Tools for the study

14. Tools explored by the researcher for reasoning ability

Table 1.5. Exhibiting Tools explored for reasoning ability

Standardised Tools for Reasoning Ability	**Author**	**Accept/Reject**	**Reason for acceptance or rejection**
Reasoning Ability test	L.N. Dubey	Rejected	It was available in Hindi only and the age range was 12 to 17 which was higher for the selected sample.
Reasoning Ability test	K. Bayati.	Rejected	It was administered to Higher secondary boys and girls, and it was available in Hindi only
Reasoning Ability test	Anuradha Joshi and B.C. Mhapatra	Rejected	It was administered to college students age group above14 years and it was administered for science only
Reasoning Ability test	Mehraj Ahmed bhat and Punita govil	Accepted	This tool is suitable for measuring reasoning ability of students at middle level. It is quite the latest in compared to others. It is available in English

15. STATISTICAL TECHNIQUES

By keeping in mind, the objectives of the study, descriptive as well as inferential statistics will be used as per the nature and distribution of scores the following statistical techniques will be used for the study.

1. Mean: Mean value will be calculated for the distribution of Visuospatial working memory, Reasoning ability and achievement in Mathematics scores.

2. Standard Deviation: Standard Deviation will be calculated to study the variation in the scores.

3. Critical ratio: Critical ratio will be employed for testing the significance of the difference between the experimental and control groups based on pre-test and post-test scores.

4. **Graphical Presentation:** Graphical representation will be used for presenting data and results in visual form.

16. Significance of the study

In the age of technology and science, it is important to have a strong foundation in mathematics for both personal and societal development. Mathematical skills and knowledge are essential in all areas of life including home, school, work, business and decision-making. As in today's time no field is left where artificial intelligence not helping. Artificial intelligence is also contributing to the field of education by making the admission, teaching and evaluation process easy.

The present study will give insight to teachers and teacher educators about the effect of Artificial Intelligent Integrated method of teaching on student's achievement, visuo-spatial working memory and reasoning ability which will be helpful for them at the stage of planning. Also, a study of Pane et al. (2017) investigated the impact of personalized learning through AI and adaptive learning systems, the study found that students using these systems showed significant improvement in math and reading skills compared to those using traditional methods at the secondary level.

This study may provide a understanding or a direction to teachers for the use of Artificial Intelligent Integrated method of teaching mathematics mathematics. Also, the study of Nitin Vijay (2023) supported this statement by their findings that is use of Artificial Intelligence (AI) in classrooms is resulting in an important change in the approaches to teaching, teachers are using AI technologies to improve student- learning.

According to the National Education Policy (2020), "Curricular and pedagogical initiatives, including the introduction of contemporary subjects such as Artificial Intelligence, Design Thinking, Holistic Health, and Organic Living, will develop important skills in students at all levels." This study may explore the relevance of Innovative tools of AI in reference to mathematics.

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